

PIP Linac, Laser Notch and TRACEWIN

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Laser Notch Review / FNAL

05-AUG-2014

Outline (and Conclusion)

- Actual TRACEWIN "start-to-end" model of the PIP linac (from the Ion Source to the Booster). MEBT quotes checked carefully with DJ.

→ In the actual "s2e" model of the TRACEWIN model, 60 mA / 100k distribution is generated at the ion source and 41949 particles reach the booster. 25.169 mA at booster from TW. Close to what is measured on the linac ("low to mid 40% transmission")

- Fernanda requested a new set of simulation to be performed to check the sensitivity of the linac to a new MEBT configuration (to accommodate for the laser notch)

→ First MEBT doublet pushed 12.5 mm closer to the MEBT buncher.

- With the new MEBT configuration, 40209 particles reach the booster without any rematching. 24.125 mA at booster. Additional loss of about 4.15 % from actual configuration.
- After a "light" rematching (lowering the MEBT quads by few percent) 41497 reach booster. 24.9 mA at booster. Additional loss of about 1% from actual configuration.

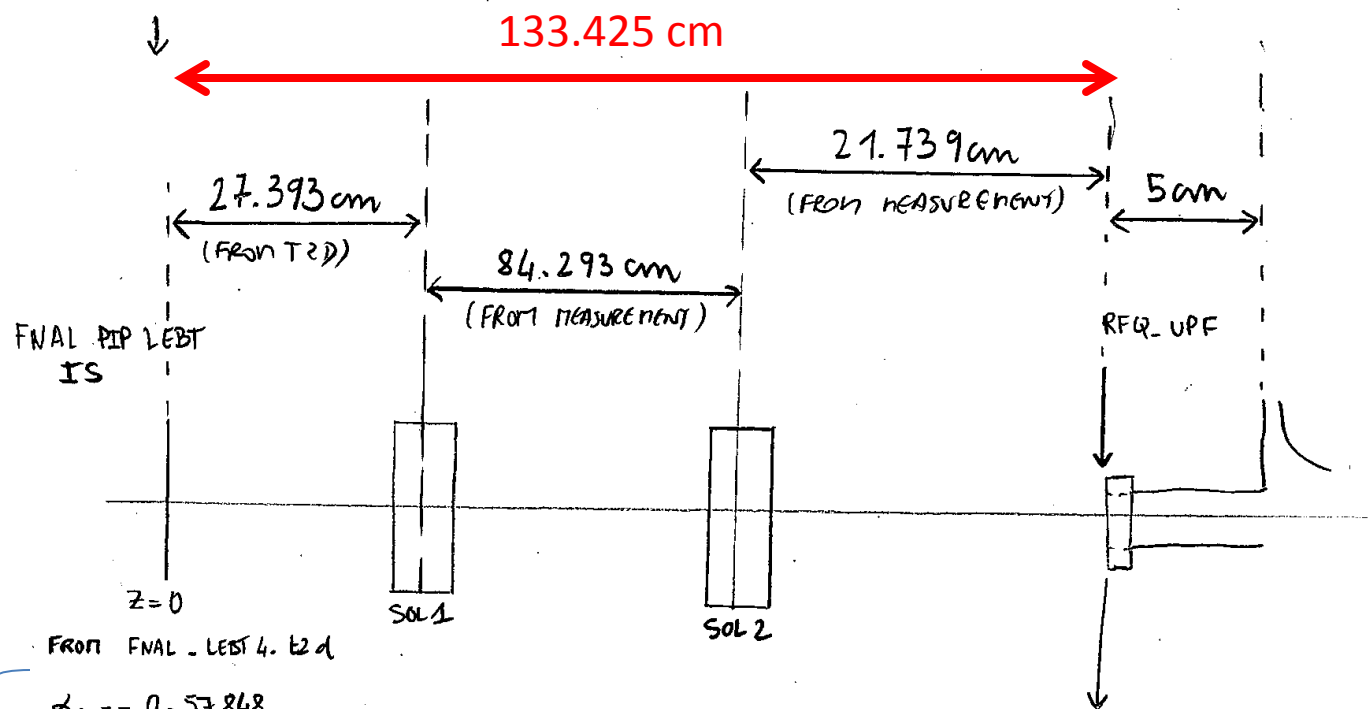
July-2014 TRACEWIN model
of the PIP linac

PIP LEBT DISTANCES (TRACEWIN Model)

13-AUG-2013

JPC

(START)



FROM FNAL - LEBT 4. E2 d

$$\alpha_x = -0.57848$$

$$\beta_x = 5.2649 \times 10^{-2} \frac{\text{mm}}{\text{mrad}}$$

$$\alpha_y = -0.40643$$

$$\beta_y = 5.6954 \times 10^{-2} \frac{\text{mm}}{\text{mrad}}$$

$$\left. \begin{array}{l} \alpha_x = 8.4 \\ \alpha_y = 8.4 \end{array} \right\} \begin{array}{l} \beta_x = 0.5 \text{ mm/mrad} \\ \beta_y = 0.5 \text{ mm/mrad} \end{array} \left\{ \begin{array}{l} \text{IF } 50 \text{ mm} \\ \text{DRIFT TUBE} \\ \text{AT } 60 \text{ mA} \end{array} \right.$$

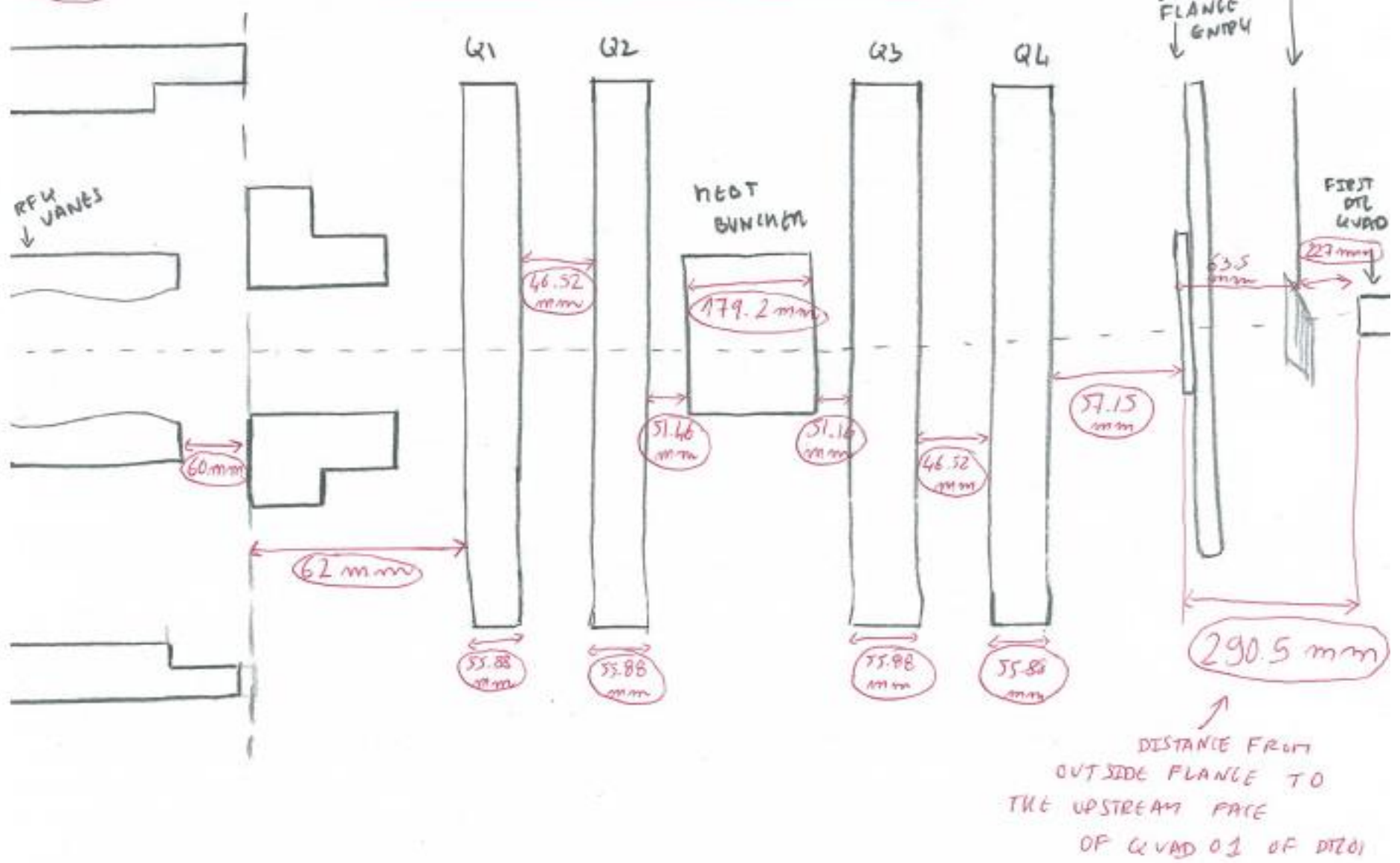
$$\left. \begin{array}{l} \alpha_x = 4.7 \\ \alpha_y = 4.7 \end{array} \right\} \begin{array}{l} \beta_x = 0.3 \text{ mm/mrad} \\ \beta_y = 0.3 \text{ mm/mrad} \end{array} \left\{ \begin{array}{l} \text{IF } 50 \text{ mm} \\ \text{DRIFT TUBE} \\ \text{AT } 0 \text{ mA} \\ (100\% \text{ NEUTRALIZED}) \end{array} \right.$$

Asymmetric

PIP MEBT DISTANCES (TRACEWIN Model)

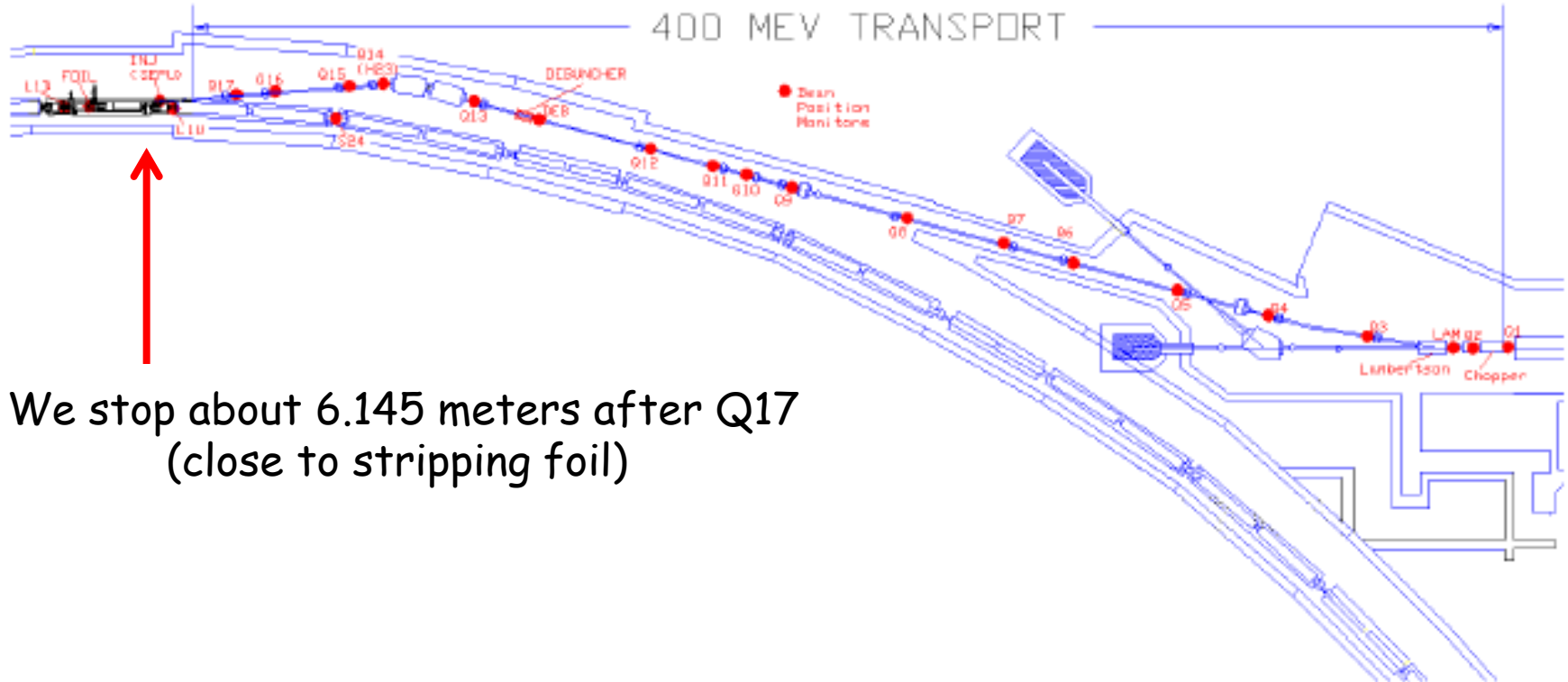
JEC
7/31/2014

ACTUAL (7/31/2014) NEBT AS
IMPLEMENTED IN TRACEWIN



At the Booster Region (TRACEWIN Model)

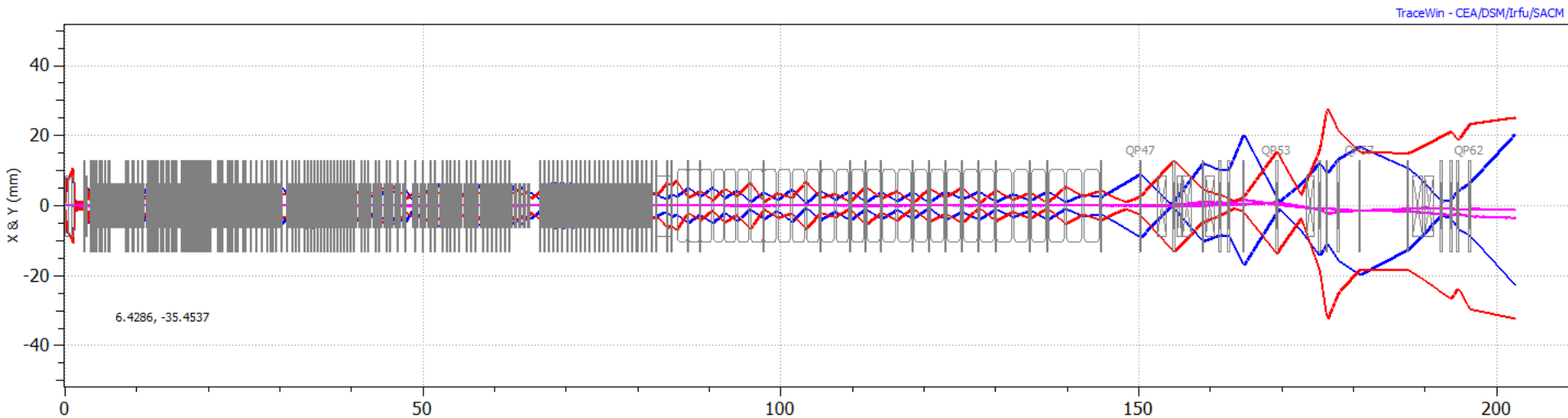
- Where does the TW model ends?: 6.145 meters downstream Q17 (see below)



We stop about 6.145 meters after Q17
(close to stripping foil)

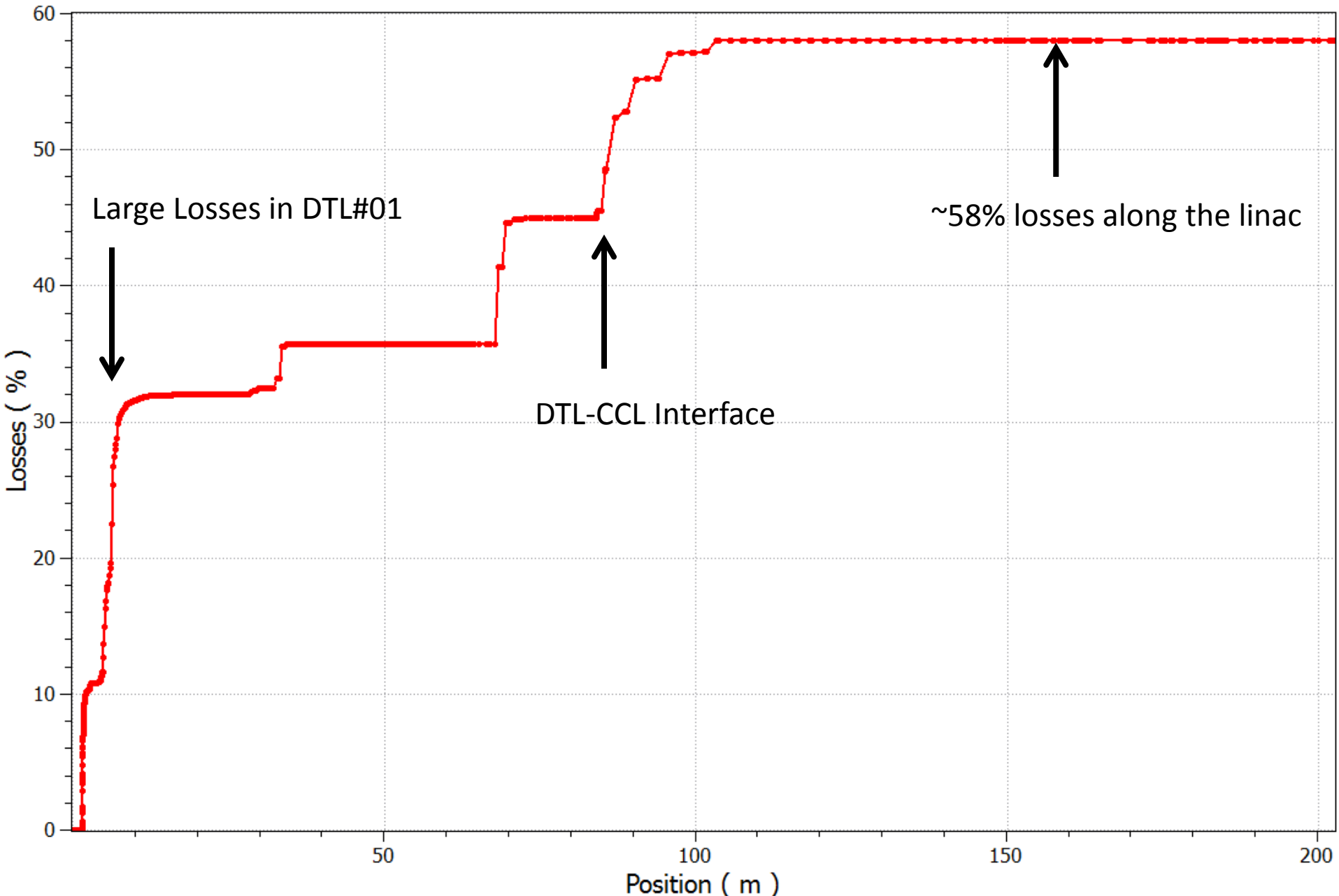
RMS Size X and Y along the PIP Linac (From TRACEWIN, July 2014 lattice)

100k / 60 mA at Ion Source. 41949 at Booster.



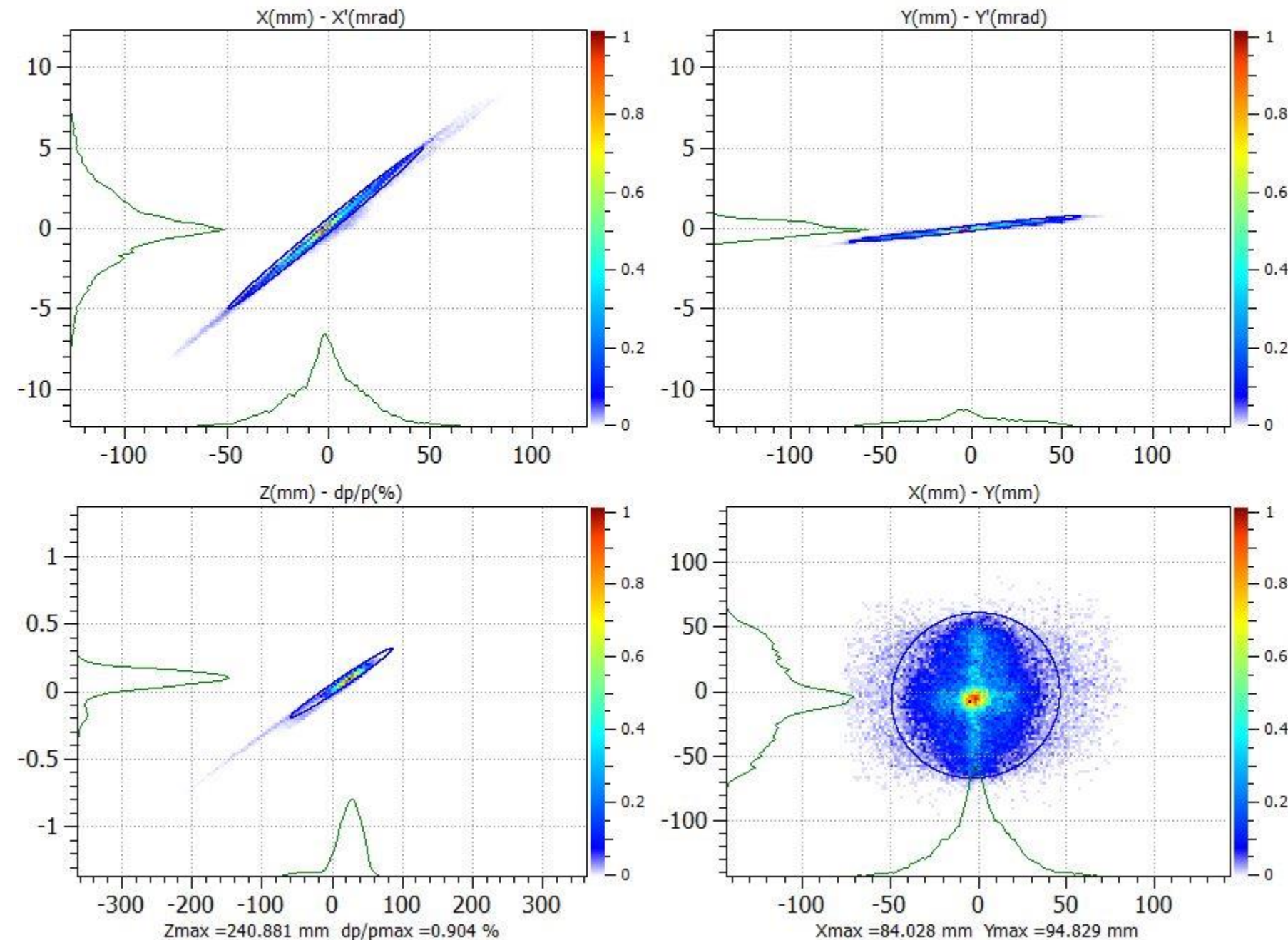
Losses along the PIP Linac (From TRACEWIN, July 2014 lattice)
100k / 60 mA at Ion Source. 41949 at Booster.

TraceWin - CEA/DSM/Irfu/SACM



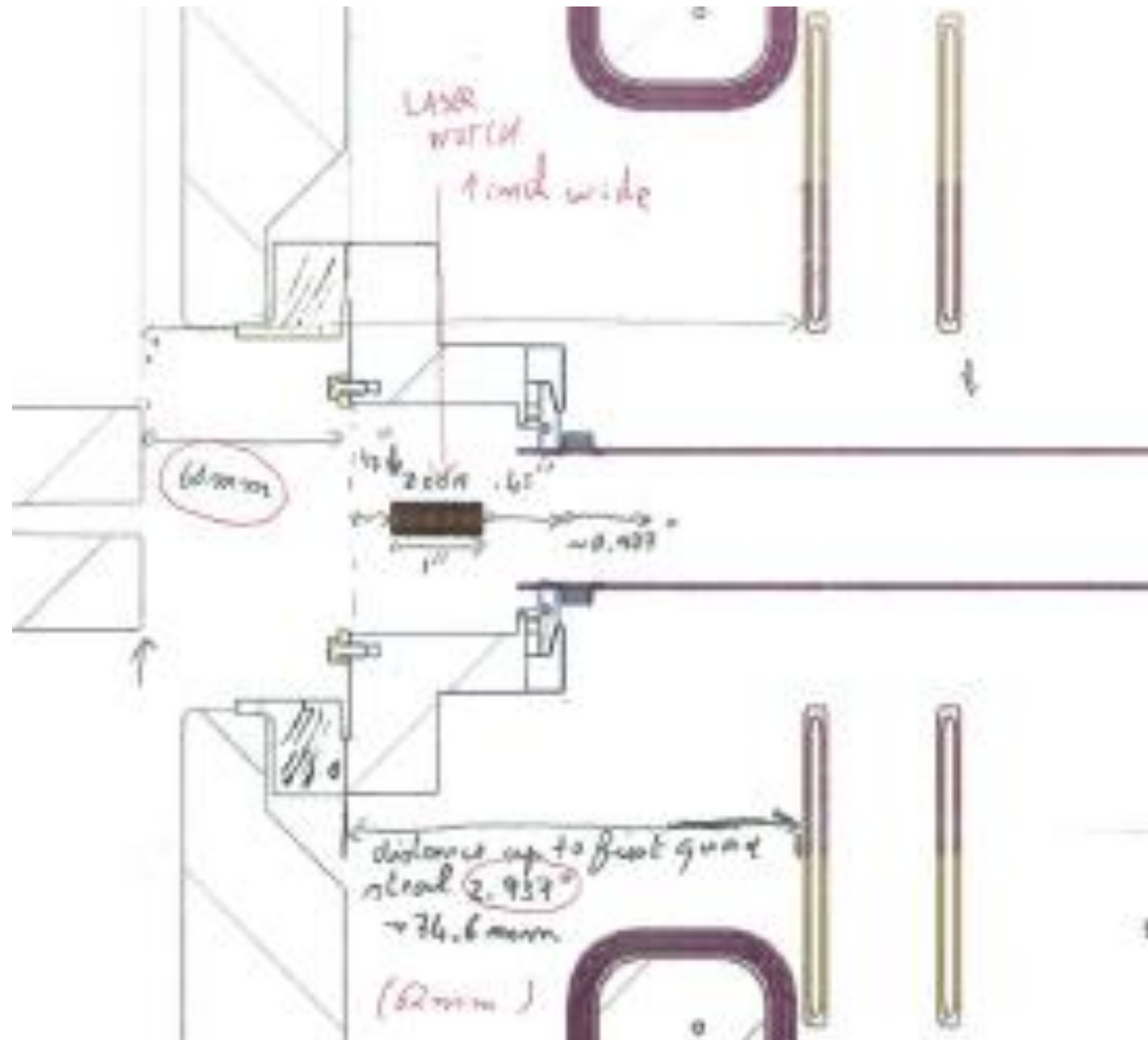
Beam distribution at booster. Baseline configuration. 41949/100k

Ele: 596 [202.547 m] NGOOD : 41949 / 100000

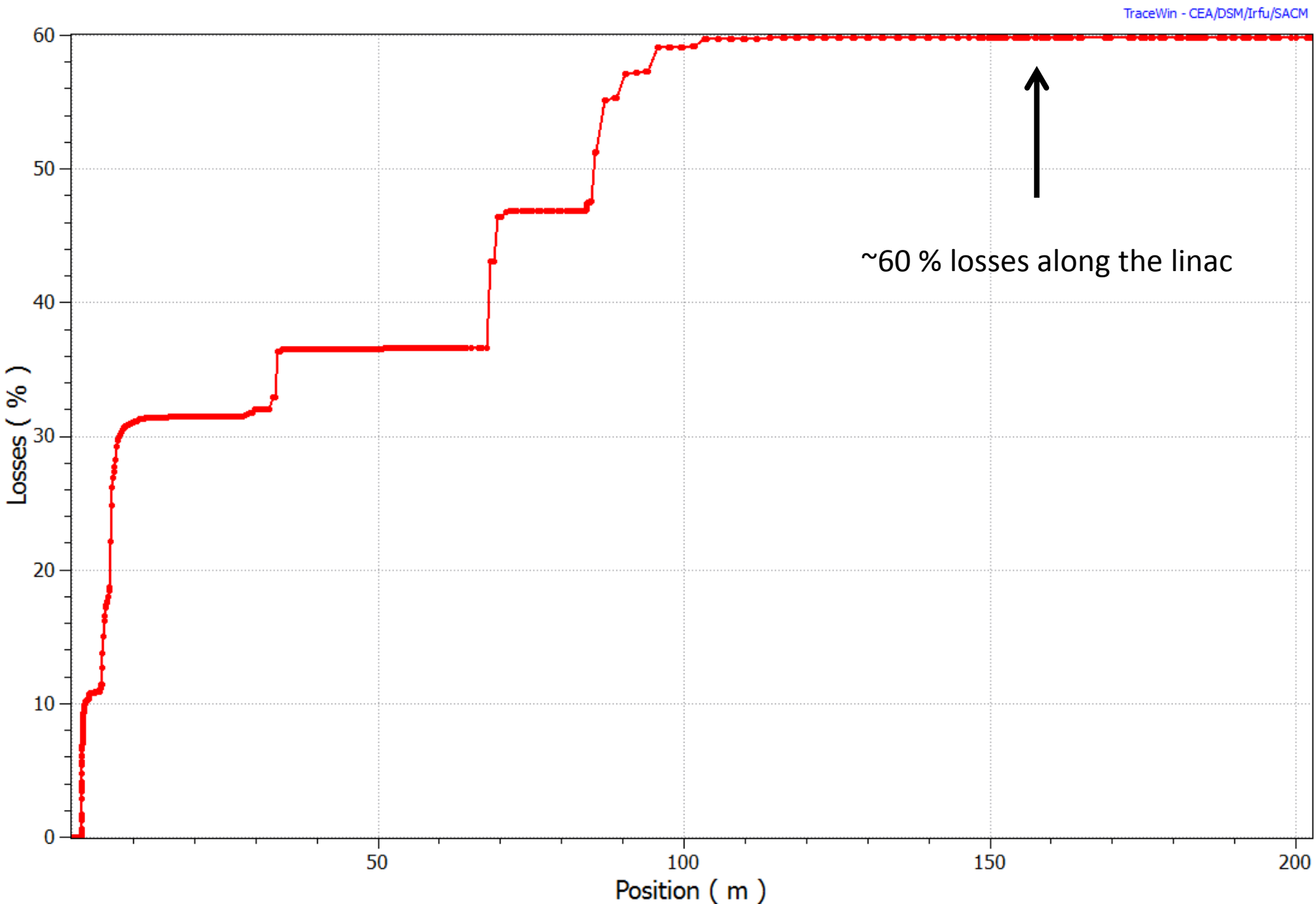


MEBT modification for laser notch installation

Laser Notch Implementation on the PIP MEBT (First doublet pushed downstream by 12.5 mm)



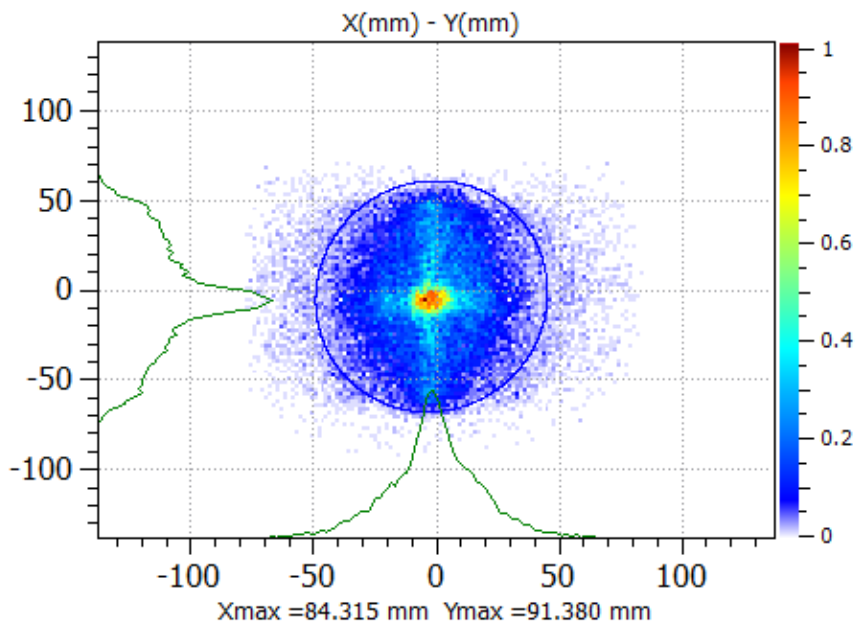
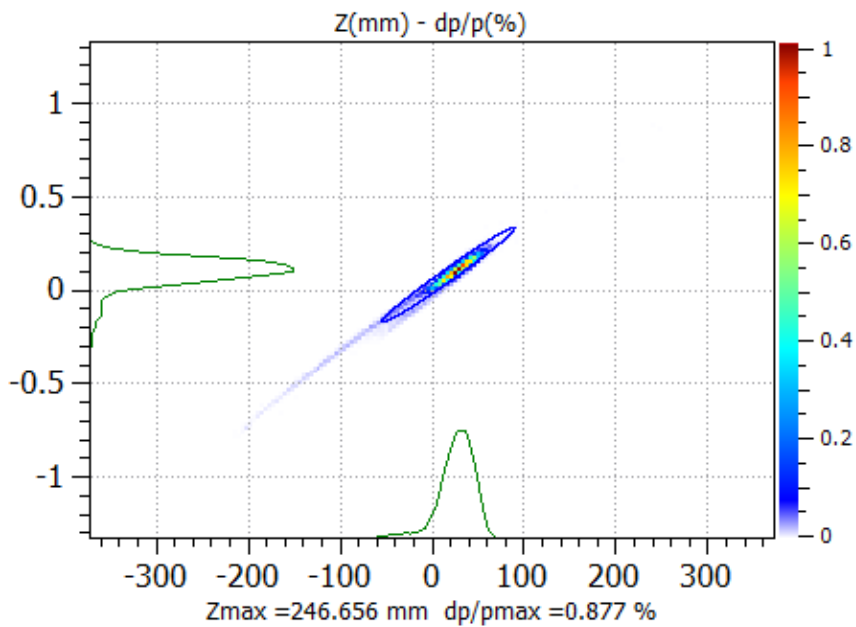
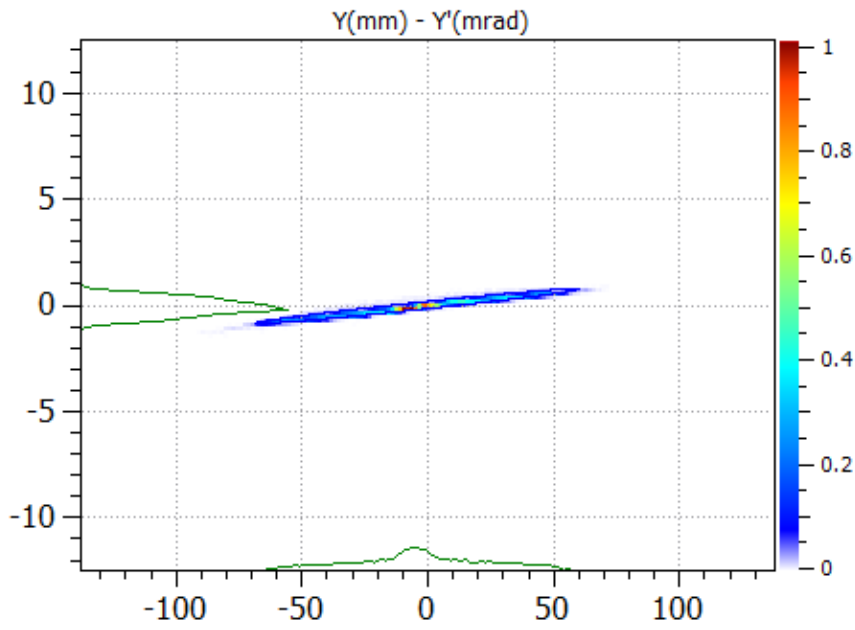
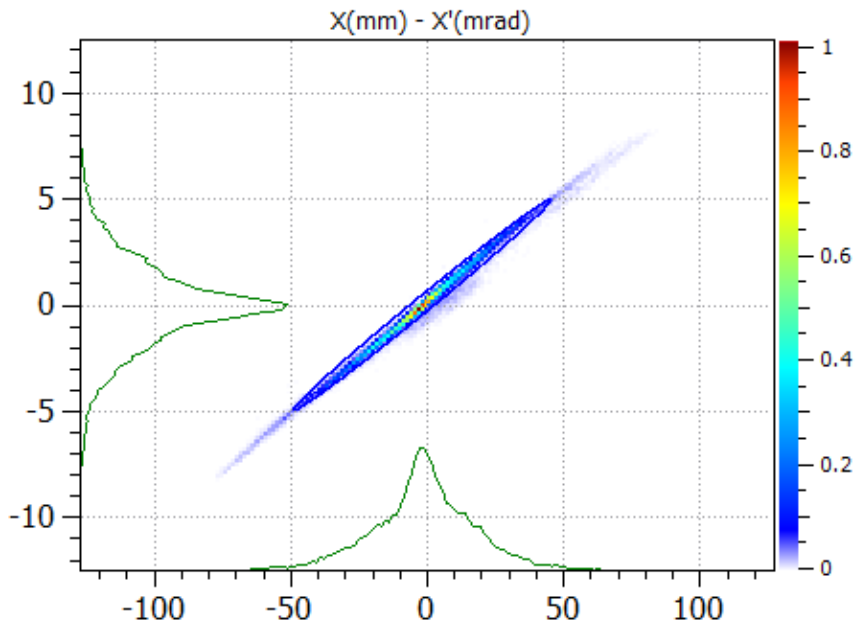
Losses along the PIP Linac (From TRACEWIN, July 2014 lattice)
100k / 60 mA at Ion Source. 40209 at Booster.



Losses along the PIP Linac (From TRACEWIN, New MEBT Configuration, No Rematching)
100k / 60 mA at Ion Source. 40209 at Booster.

TraceWin - CEA/DSM/Irfu/SACM

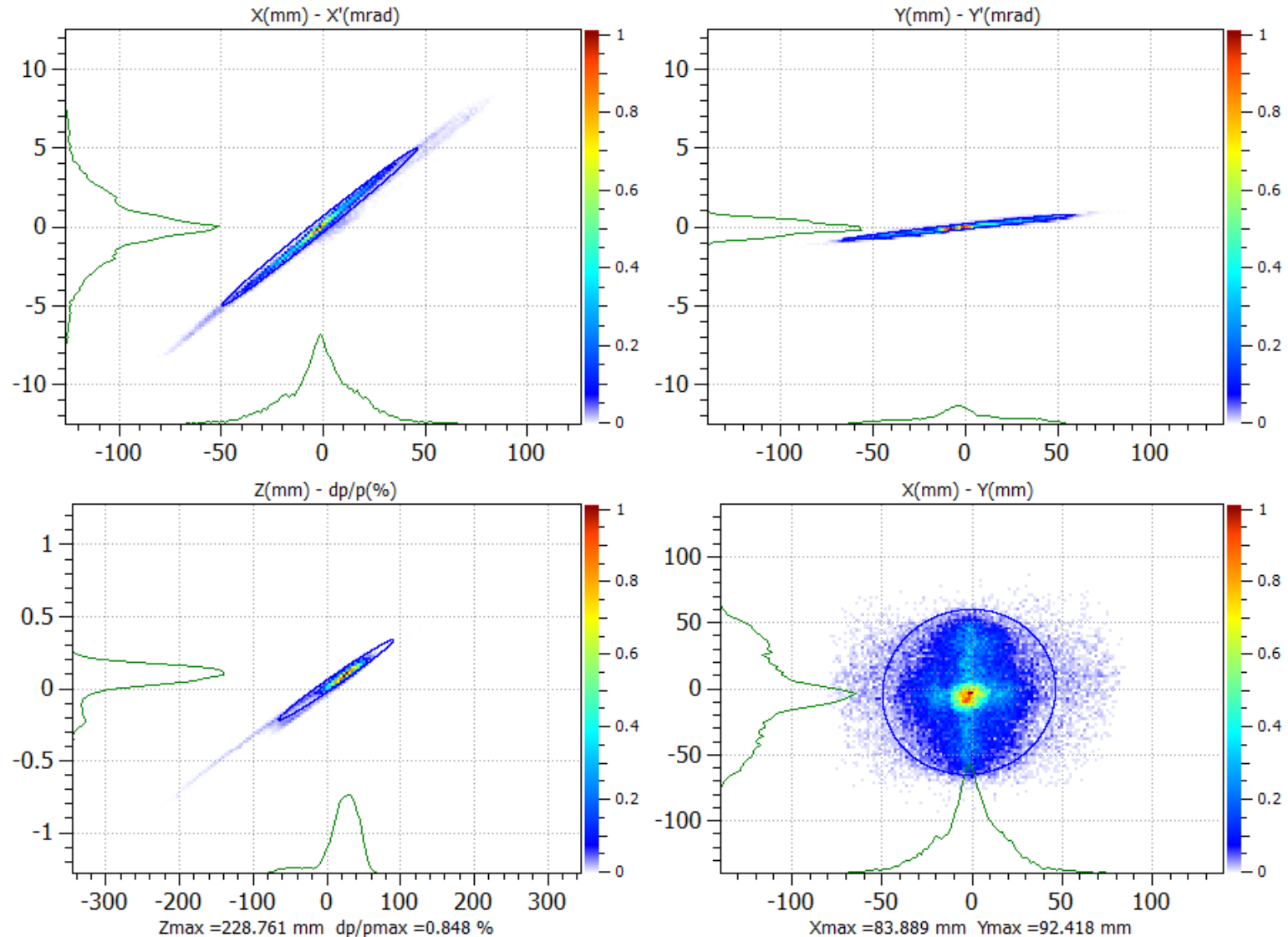
Ele: 596 [202.547 m] NGOOD : 40209 / 100000



Losses along the PIP Linac (From TRACEWIN, New MEBT Configuration, After Rematching)
First MEBT doublet lowered by ~4%. Second MEBT Doublet by about 2%.
100k / 60 mA at Ion Source. 41453 at Booster.

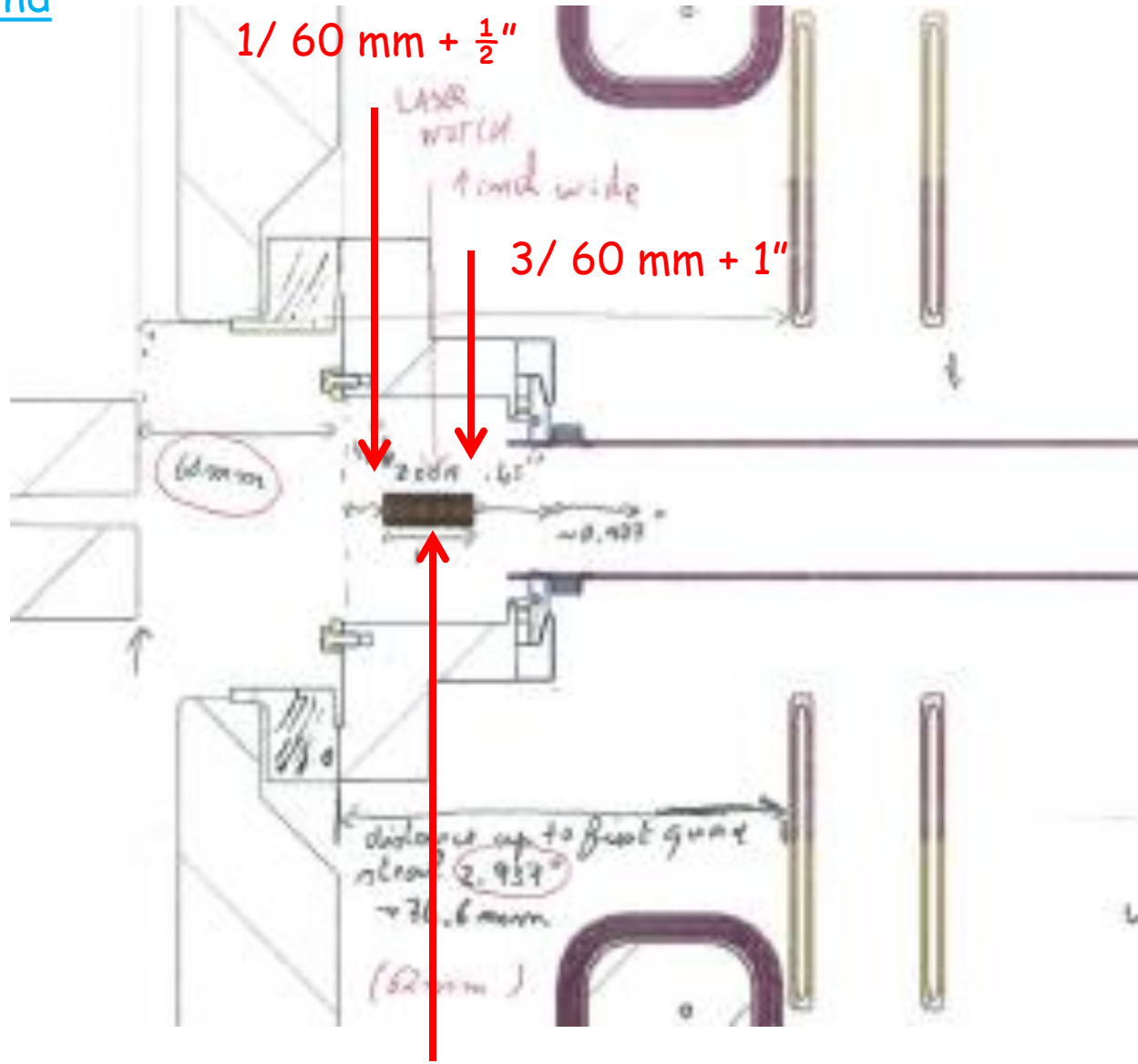
TraceWin - CEA/DSM/Irfu/SACM

Ele: 596 [202.547 m] NGOOD : 41543 / 100000



Beam Sizes at the laser notch
Installation (3 locations)

Start/Middle/End



$2/60 \text{ mm} + 1.5''$

1/ 60 mm + 12.7 mm from RFQ (1/2 inch)

Ele: 111 [2.66069 m] NGOOD : 89659 / 100000

X-X'

Emit [rms] = 0.4068 Pi.mm.mrad [Norm.]
Emit [93.10%] = 2.0340 Pi.mm.mrad [Norm.]
Beta = 0.1598 mm/Pi.mrad
Alpha = -1.1651

Y-Y'

Emit [rms] = 0.3687 Pi.mm.mrad [Norm.]
Emit [92.61%] = 1.8435 Pi.mm.mrad [Norm.]
Beta = 0.2385 mm/Pi.mrad
Alpha = -2.6274

Phase-Energy

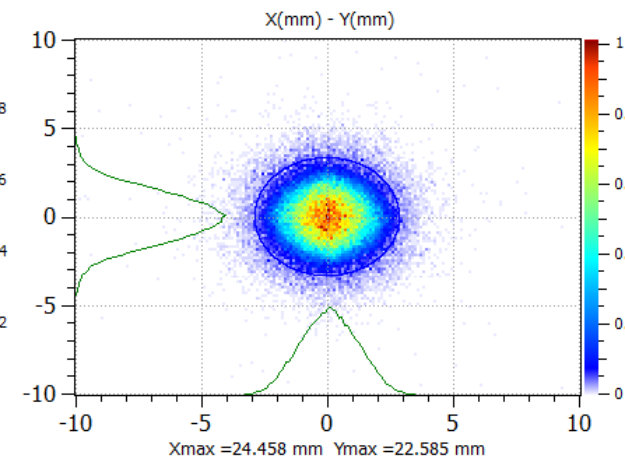
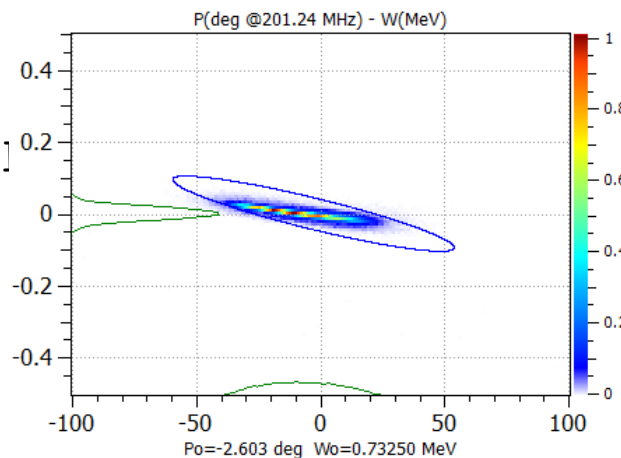
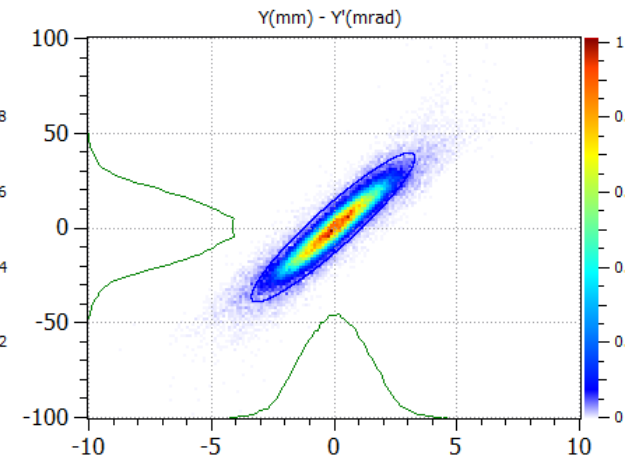
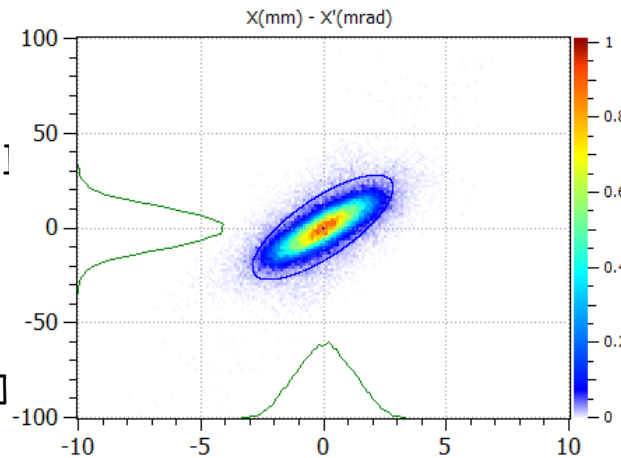
Emit [rms] = 0.5067 Pi.deg.MeV [Norm.]
Emit [97.05%] = 2.5334 Pi.deg.MeV [Norm.]
Beta = 1272.5465 deg/Pi.MeV
Alpha = 2.1188

X-Y

Emit [rms] = 1.9142 mm² [Norm.]
Emit [93.17%] = 9.5711 mm² [Norm.]
Beta = 0.8598
Alpha = 0.0021
Beta = 0.039468547 Gamma = 1.000779794
Mo = 939.29402679 MeV

4D (X-X'-Y-Y')

E [rms] = 0.1499518893 (Pi.mm.mrad)² [Norm.]



Sigma_X [rms] = 1.2829 mm

Sigma_X' [rms] = 12.3256 mrad

Sigma_Y [rms] = 1.4921 mm

Sigma_Y' [rms] = 17.5867 mrad

Sigma_Phase [rms] = 25.3926 deg

Sigma_Energy [rms] = 0.0468 MeV

Sigma_X [rms] = 1.2829 mm

Sigma_Y [rms] = 1.4921 mm

2/ 60 mm + 25.4 mm from RFQ (1 inch)

iracewin - LEA/USM/IRFU/SALM

Ele: 112 [2.67339 m] NGOOD : 89659 / 100000

X-X'

Emit [rms] = 0.4040 Pi.mm.mrad [Norm.]
 Emit [93.02%] = 2.0198 Pi.mm.mrad [Norm.]
 Beta = 0.1941 mm/Pi.mrad
 Alpha = -1.4401

Y-Y'

Emit [rms] = 0.3679 Pi.mm.mrad [Norm.]
 Emit [92.50%] = 1.8396 Pi.mm.mrad [Norm.]
 Beta = 0.3125 mm/Pi.mrad
 Alpha = -3.1596

Phase-Energy

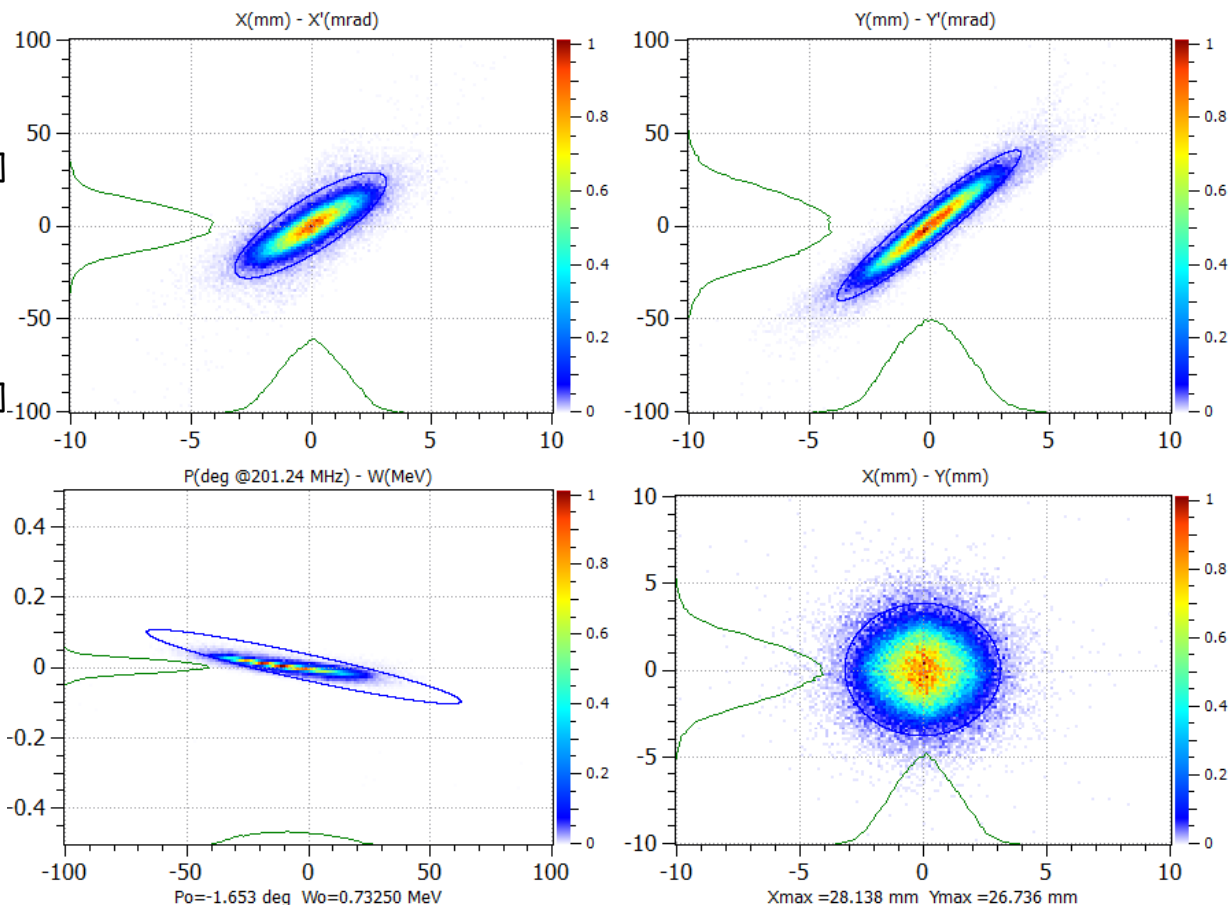
Emit [rms] = 0.4842 Pi.deg.MeV [Norm.]
 Emit [96.46%] = 2.4212 Pi.deg.MeV [Norm.]
 Beta = 1723.6946 deg/Pi.MeV
 Alpha = 2.6180

X-Y

Emit [rms] = 2.4039 mm² [Norm.]
 Emit [93.50%] = 12.0194 mm² [Norm.]
 Beta = 0.8258
 Alpha = 0.0013
 Beta = 0.039469278 Gamma = 1.000779823
 Mo = 939.29402679 MeV

4D (X-X'-Y-Y')

E [rms] = 0.1485924931 (Pi.mm.mrad)² [Norm.]



Sigma_X [rms] = 1.4089 mm

Sigma_X' [rms] = 12.7266 mrad

Sigma_Y [rms] = 1.7062 mm

Sigma_Y' [rms] = 18.0924 mrad

Sigma_Phase [rms] = 28.8908 deg

Sigma_Energy [rms] = 0.0470 MeV

Sigma_X [rms] = 1.4089 mm

Sigma_Y [rms] = 1.7062 mm

3/ 60 mm + 38.1 mm from RFQ (1.5 inches)

Ele: 113 [2.68609 m] NGOOD : 89659 / 100000

modsim - c:\pangajay\modsim

X-X'

Emit [rms] = 0.4015 Pi.mm.mrad [Norm.]

Emit [92.93%] = 2.0077 Pi.mm.mrad [Norm.]

Beta = 0.2356 mm/Pi.mrad

Alpha = -1.7239

Y-Y'

Emit [rms] = 0.3679 Pi.mm.mrad [Norm.]

Emit [92.41%] = 1.8393 Pi.mm.mrad [Norm.]

Beta = 0.3997 mm/Pi.mrad

Alpha = -3.7066

Phase-Energy

Emit [rms] = 0.4635 Pi.deg.MeV [Norm.]

Emit [95.75%] = 2.3175 Pi.deg.MeV [Norm.]

Beta = 2279.7234 deg/Pi.MeV

Alpha = 3.1538

X-Y

Emit [rms] = 2.9856 mm² [Norm.]

Emit [93.78%] = 14.9282 mm² [Norm.]

Beta = 0.8020

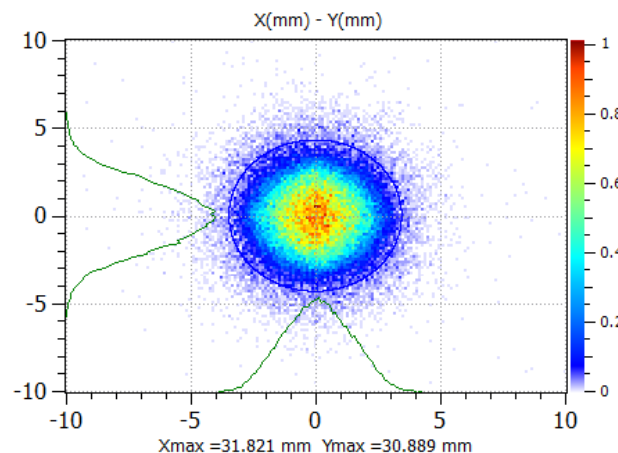
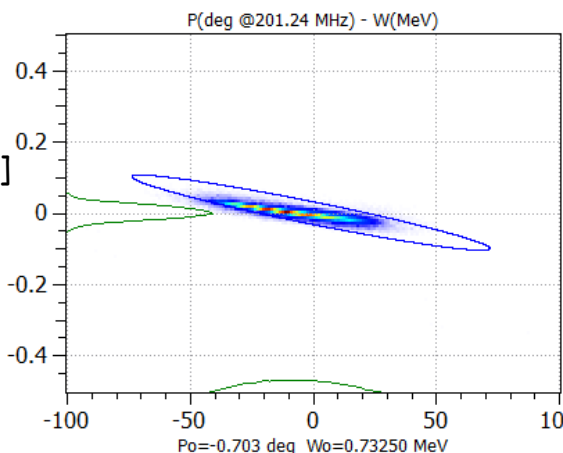
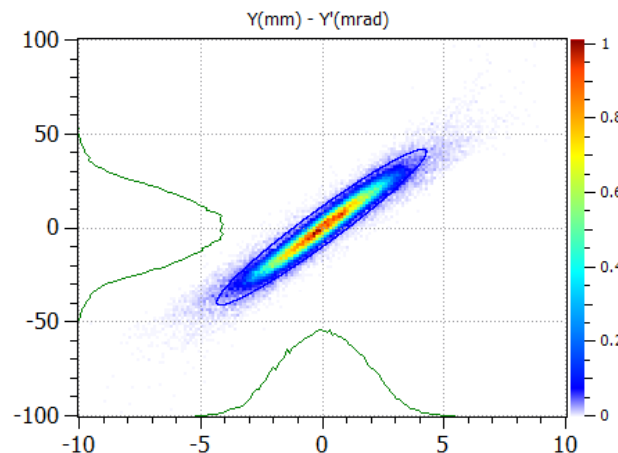
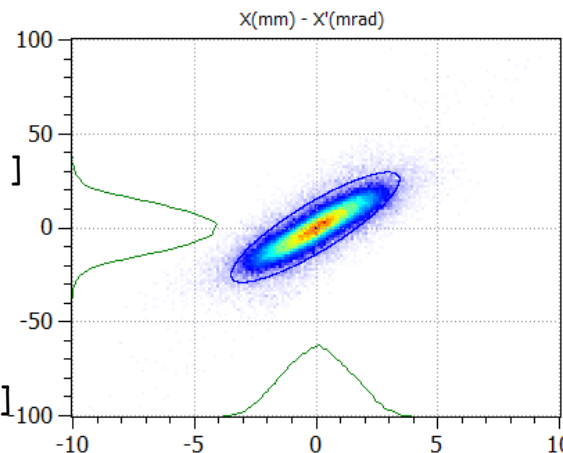
Alpha = 0.0006

Beta = 0.039469944 Gamma = 1.000779850

Mo = 939.29402679 MeV

4D (X-X'-Y-Y')

E [rms] = 0.1476744903 (Pi.mm.mrad)² [Norm.]



Sigma_X [rms] = 1.5474 mm

Sigma_X' [rms] = 13.0920 mrad

Sigma_Y [rms] = 1.9294 mm

Sigma_Y' [rms] = 18.5302 mrad

Sigma_Phase [rms] = 32.5062 deg

Sigma_Energy [rms] = 0.0472 MeV

Sigma_X [rms] = 1.5474 mm

Sigma_Y [rms] = 1.9294 mm